Set - associative caching device organized as
M number of sets with N elements in each set.

FIG.1
(PRIOR ART)
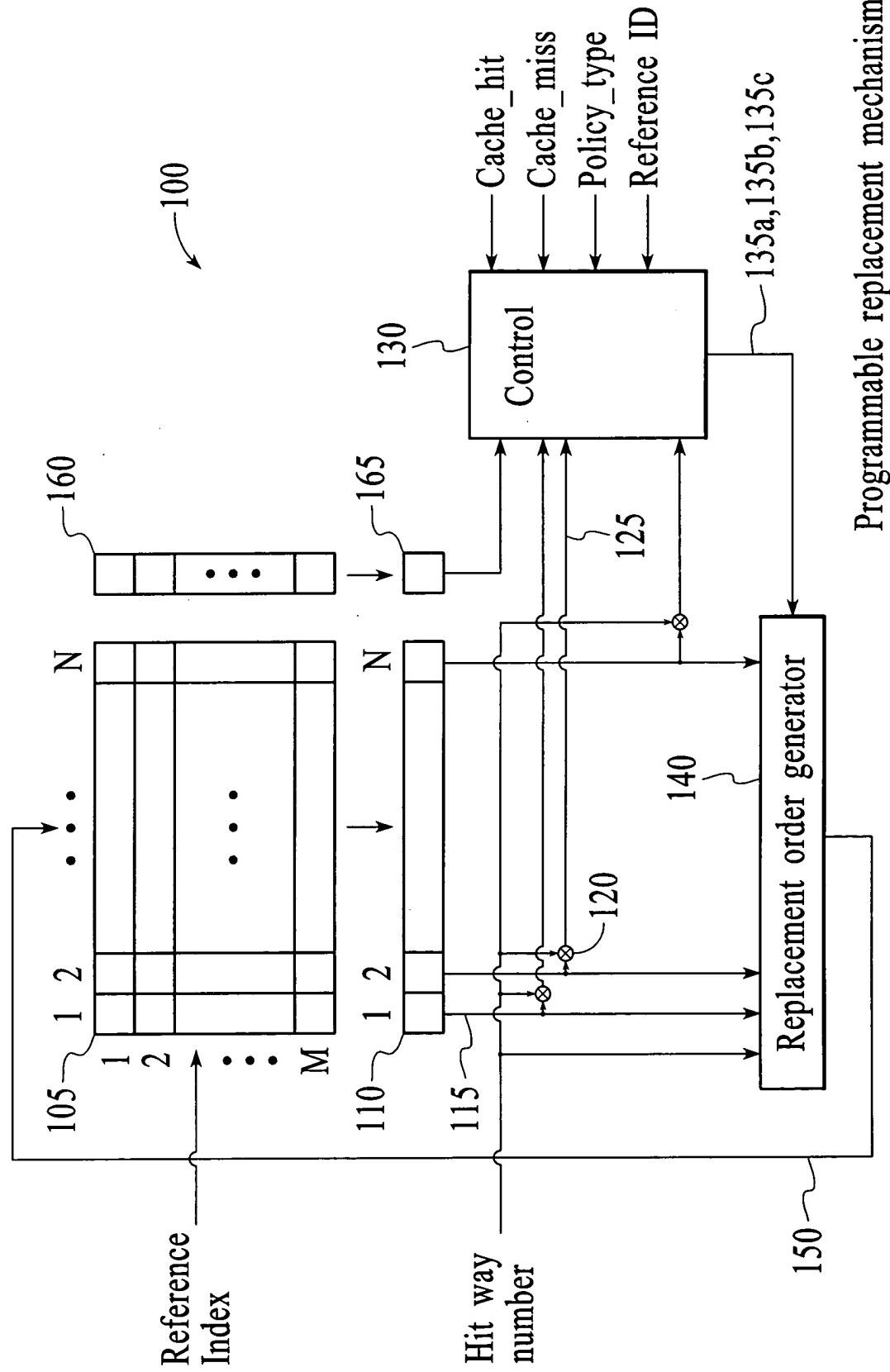
FIG.2

Programmable replacement mechanism

135a (Replace-way selector)

135b (Boundary-way selector)

Hit way number

135c

115

W_N ... W_{i+1} W_i W_{i-1} ... W_1

150

W_N' ... W_{i+1}' W_i' W_{i-1}' ... W_1'

140

141

142

143

144

L S F B H R

145

(position selector)

Replacement order generator

FIG.3

110 ⌐

	1	2	3		N-1	N
	D	B	C	• • •	E	F

140 {

|	S	R	R		R	R	H
	D	C		• • •		F	B

— Hit way number

150 ⌐ | 1 | 2 | 3 | | N-1 | N |
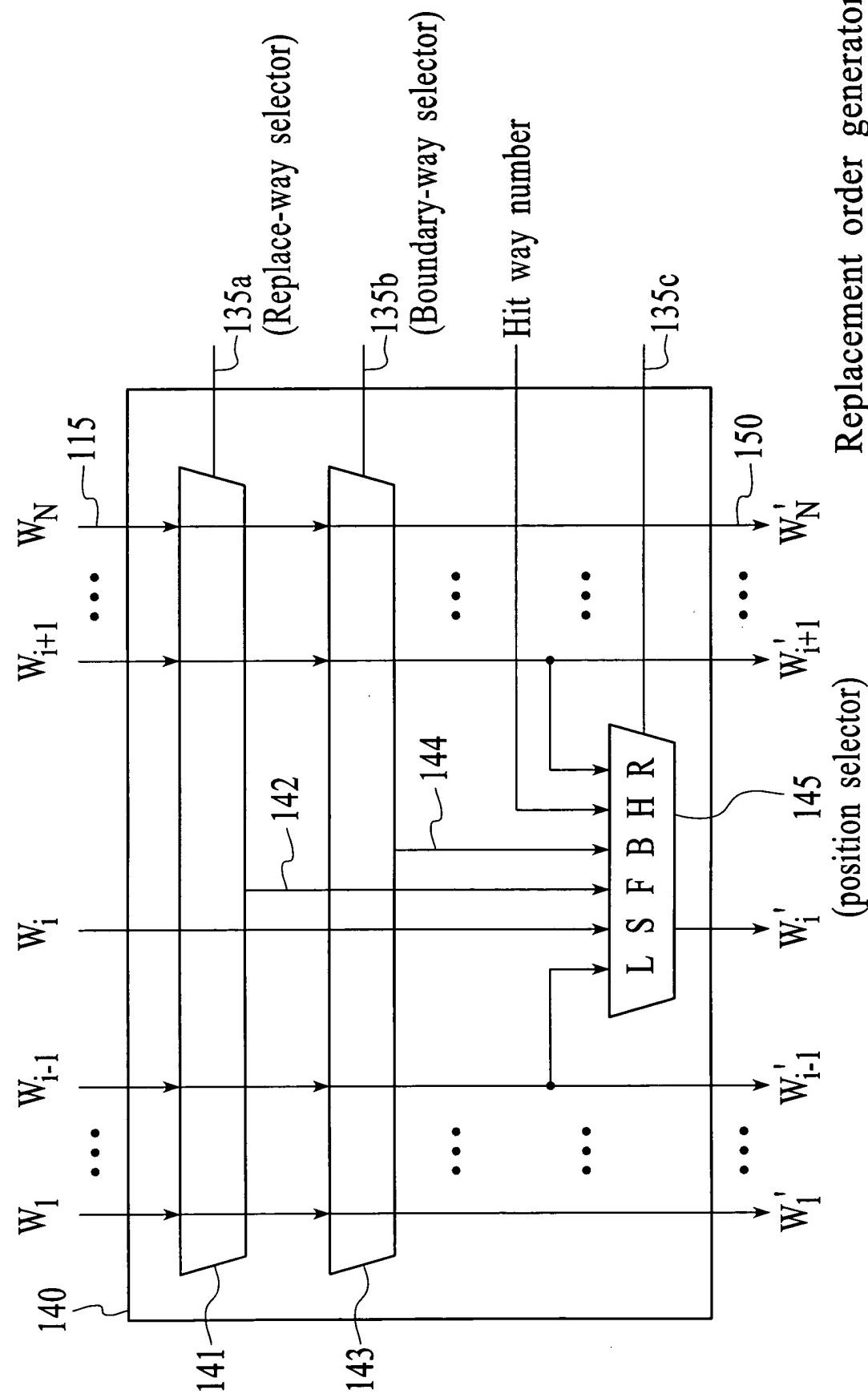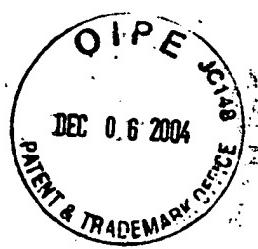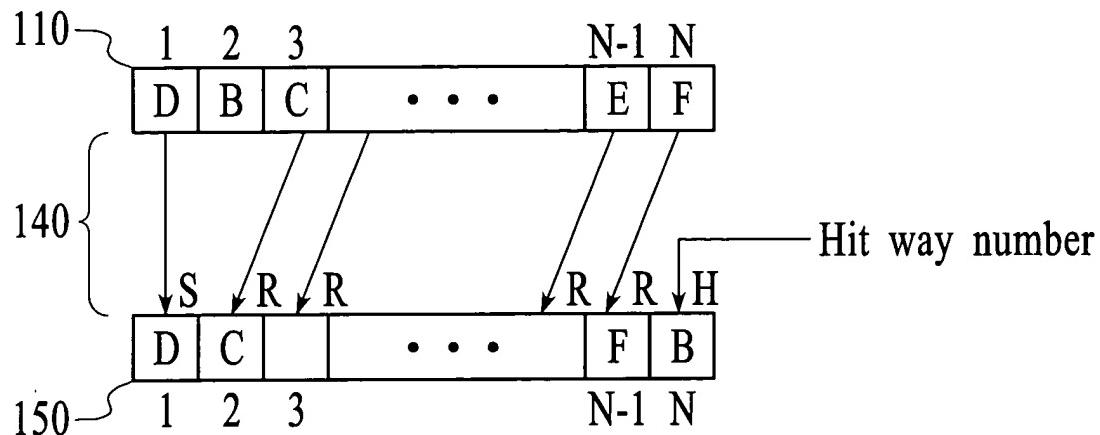
Replacement order generator producing
new replacement order when a reference
is hit on element residing in way B.

FIG.4

110 ⌐

	1	2	3		N-1	N
	D	B	C	• • •	E	F

140 {

	R	R	R		R	R	F
	B	C		• • •		F	D

— Replace
way number
(142)

150 ⌐ | 1 | 2 | 3 | | N-1 | N |
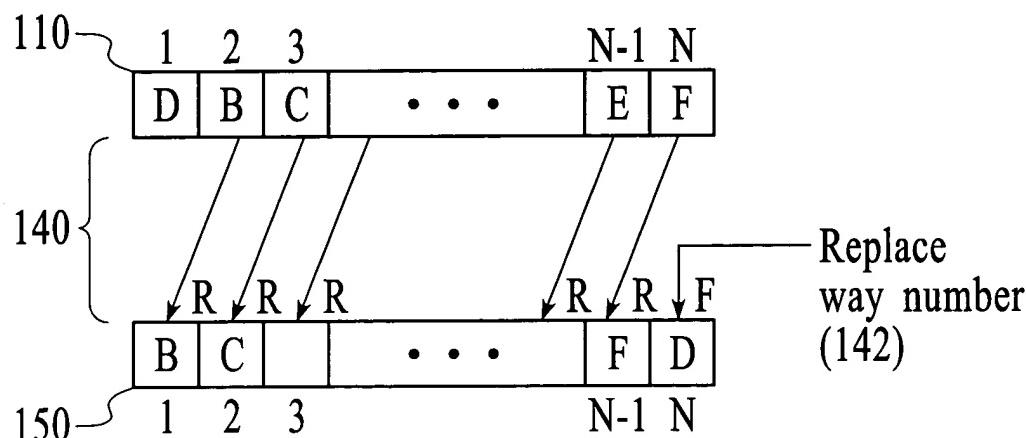
Replacement order generator producing new
replacement order when a reference is a miss.

FIG.5

| Access Result	mux 1	mux 2	mux 3	mux 4	mux 5	mux 6	mux 7	mux 8
miss	R	R	R	R	R	R	R	F
hit 1	R	R	R	R	R	R	R	H
hit 2	S	R	R	R	R	R	R	H
hit 3	S	S	R	R	R	R	R	H
hit 4	S	S	S	R	R	R	R	H
hit 5	S	S	S	S	R	R	R	H
hit 6	S	S	S	S	S	R	R	H
hit 7	S	S	S	S	S	S	R	H
hit 8	S	S	S	S	S	S	S	H/S

Table 1

FIG.5A
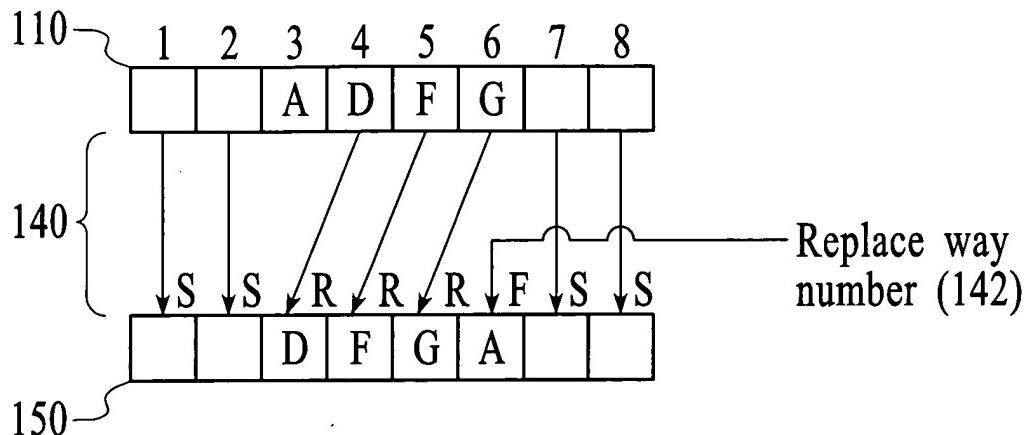
When a reference is a miss and the reference
partition consists of positions 3-6.

FIG.6
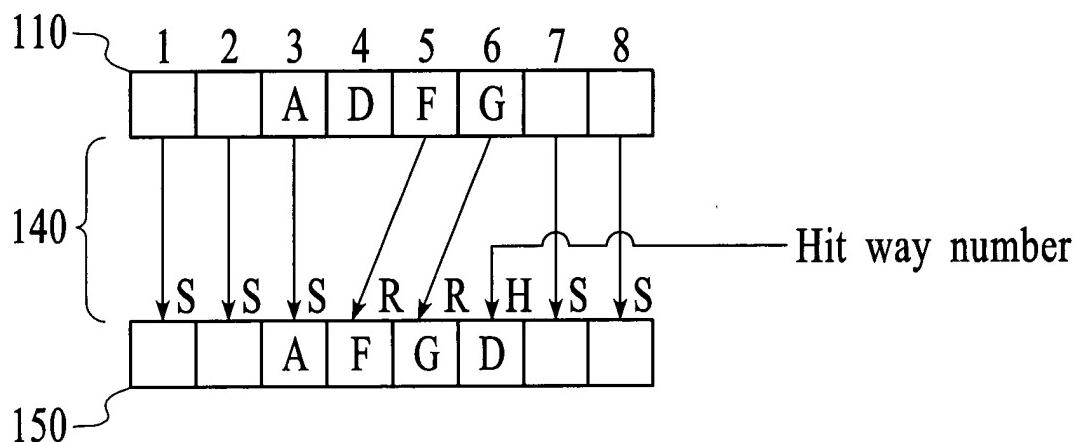
When a reference hits on way D that resides
in a position within the reference partition
consisting of positions 3-6.

FIG.7

110 — | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
       | | | A | D | F | G | | E |

140 {

Hit way number

Replace way number (142)

S | S | R | R | R | H | S | F
  | | D | F | G | E | | A

150 —
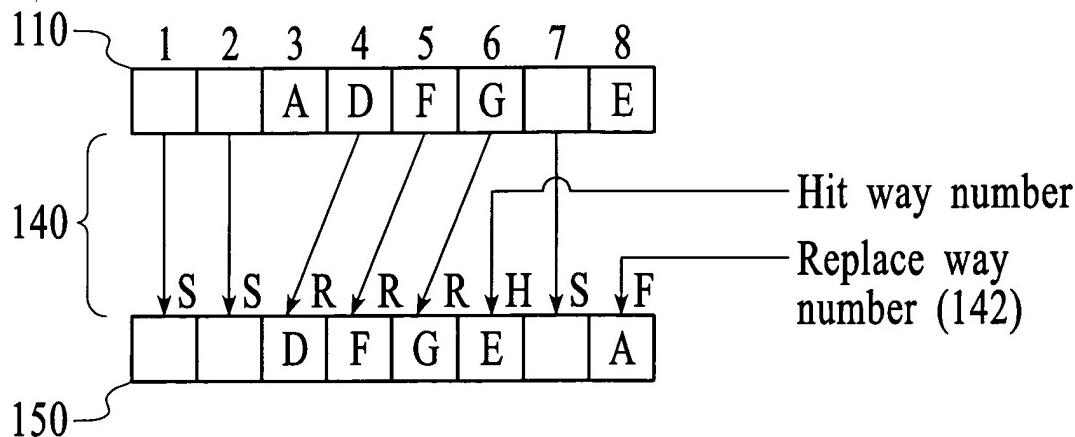
When a reference hits on way E that resides
in a position outside the reference partition
consisting of positions 3-6.

FIG.8

Shared Partition   Private Partition

110 — | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
       | B | D | E | | | C | F | G |

140 {

Boundary way number (144)

Replace way number (142)

R | R | B | S | S | R | R | F
D | E | C | | | F | G | B

150 —
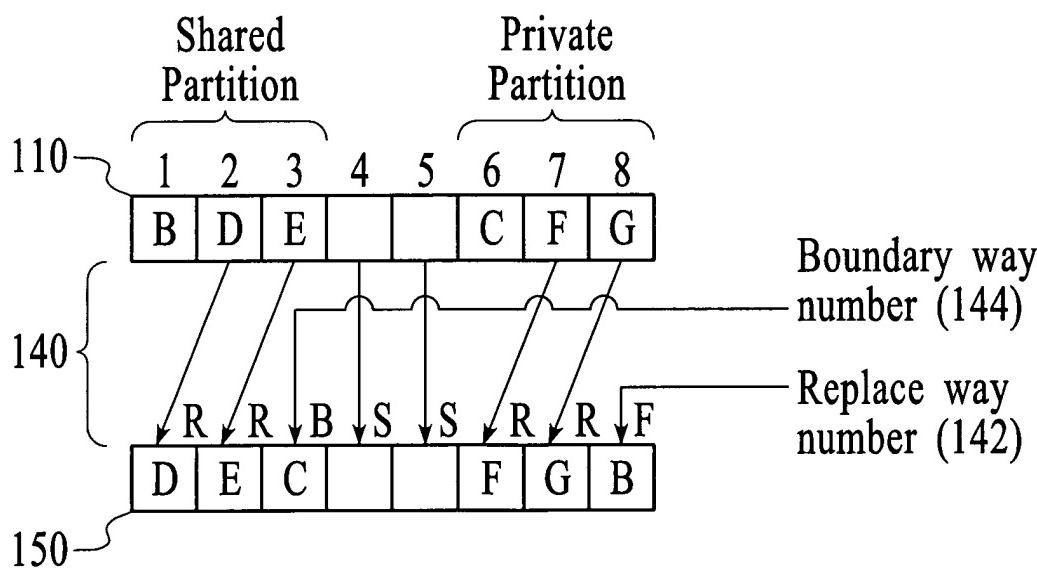
Miss

FIG.9

ID	Access Result	mux 1	mux 2	mux 3	mux 4	mux 5	mux 6	mux 7	mux 8	Fsel
Y	miss	S	S	R	R	R	F	S	S	3
Y	hit 1	F	S	R	R	R	H	S	S	3
Y	hit 2	S	F	R	R	R	H	S	S	3
Y	hit 3	S	S	R	R	R	H	S	S	3
Y	hit 4	S	S	S	R	R	H	S	S	3
Y	hit 5	S	S	S	S	R	H	S	S	3
Y	hit 6	S	S	S	S	S	H/S	S	S	3
Y	hit 7	S	S	R	R	R	H	F	S	3
Y	hit 8	S	S	R	R	R	H	S	F	3

Table 2

FIG.8A

Shared
Partition

Private
Partition

110

1	2	3	4	5	6	7	8
B	D	E			C	F	G

140

Hit way number

S   S   S   S   S   R   R   H

B	D	E			F	G	E

150
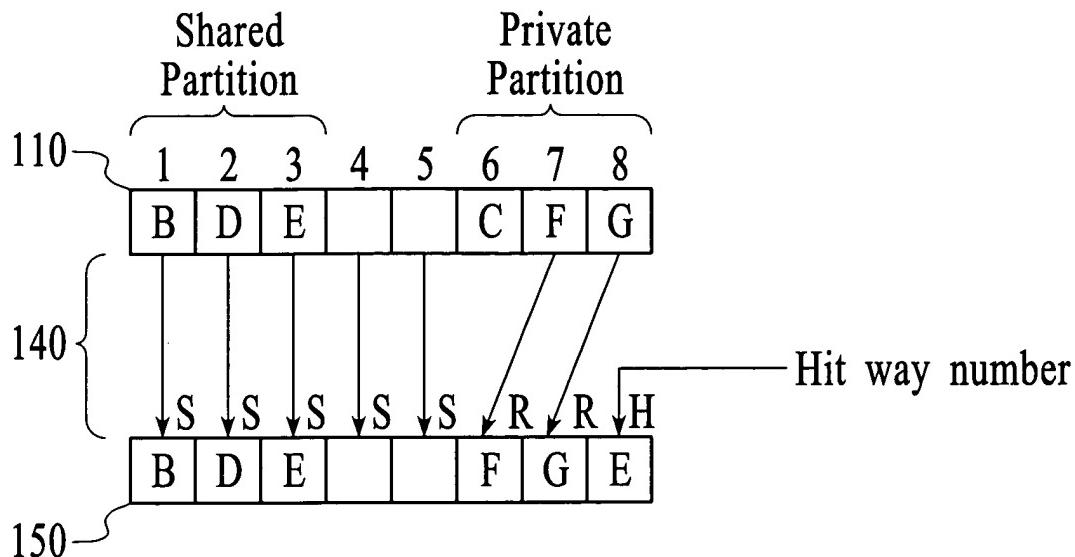
Hit on way C, which resides in private partition.

FIG.10

Shared
Partition

Private
Partition

110

1	2	3	4	5	6	7	8
B	D	E			C	F	G

140

Boundary way
number (144)

Hit way number

S   R   B   S   S   R   R   H

B	E	C			F	G	D

150
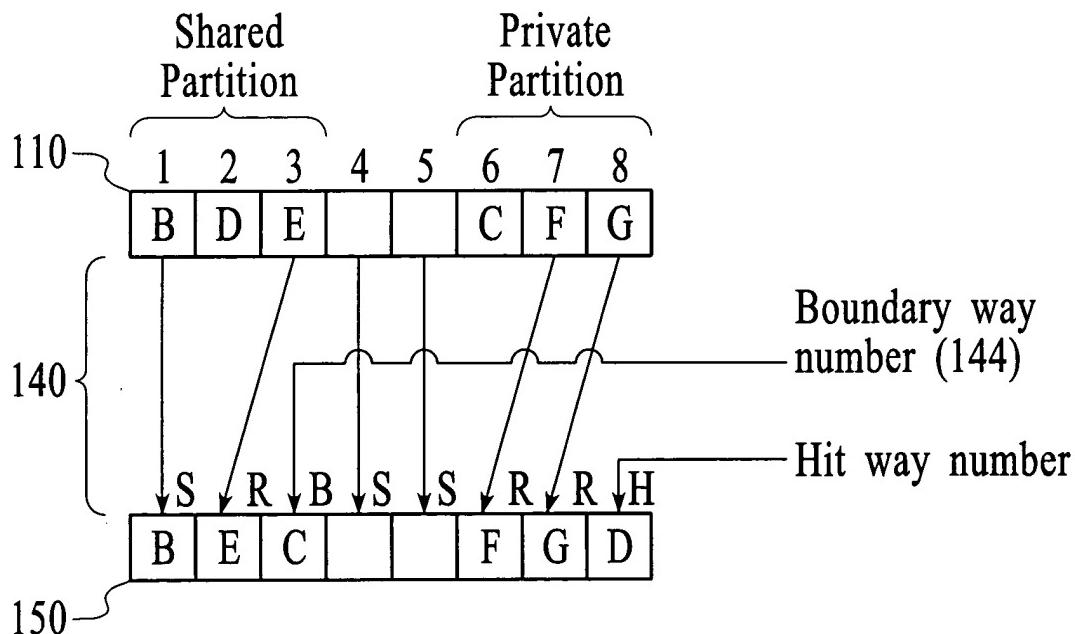
Hit on way D, which resides in shared partition.

FIG.11

Shared
Partition

Private
Partition

110 —

1	2	3	4	5	6	7	8
B	D	E	J		C	F	G

Boundary way
number (144)

Replace way
number (142)

Hit way number

140 {

R	R	B	F	S	R	R	H
D	E	C	B		F	G	J

150 —

Hit on way J, which resides outside
the shared and private partitions.

FIG.12

Locked
Partition

Unlocked
Partition

110 —

1	2	3	4	5	6	7	8
C	D	A	B	F	E	H	G

140 {

S	S	S	S	S	S	S	S
C	D	A	B	F	E	H	G

150 —
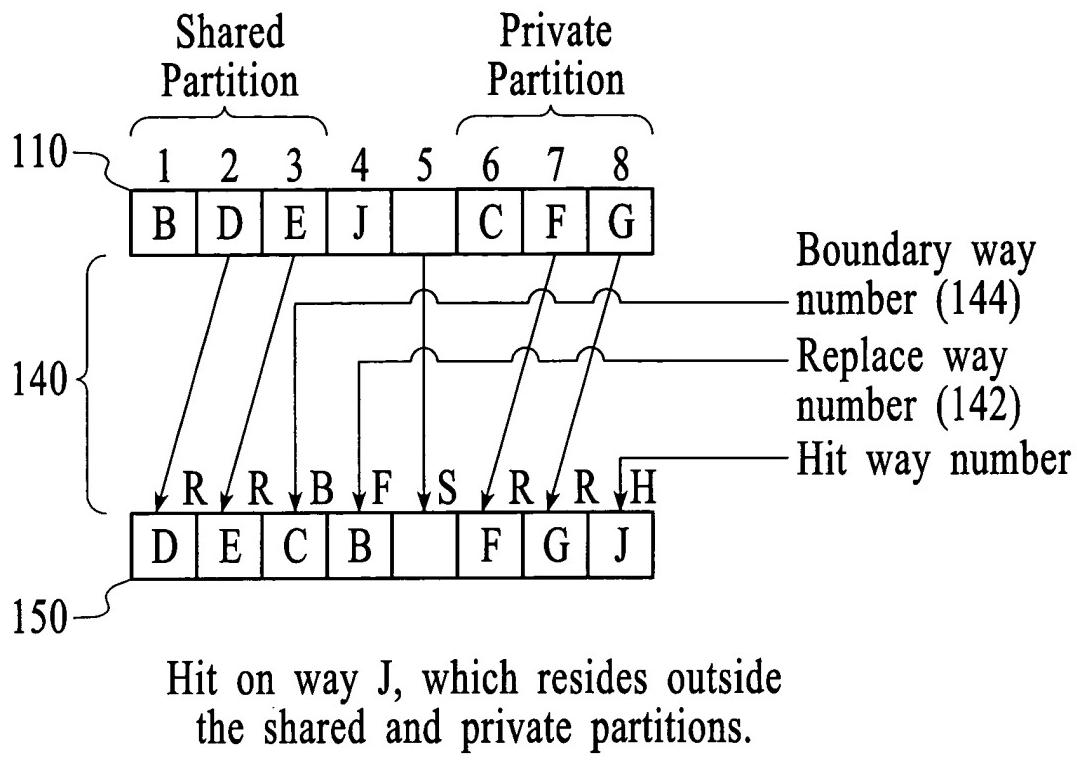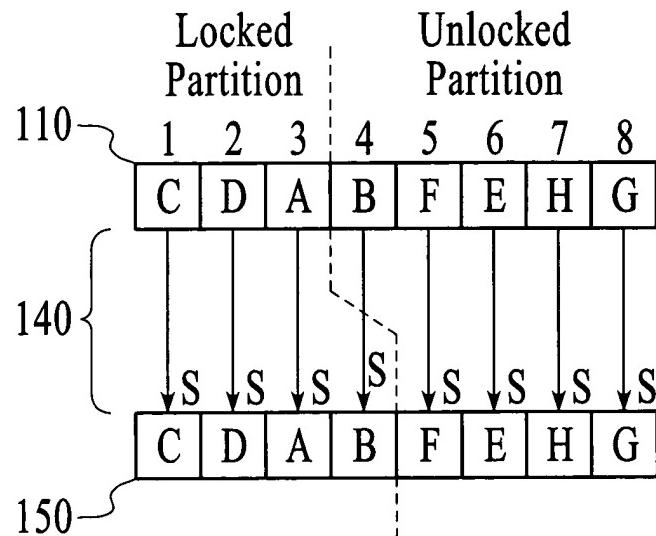
Locking an element that is not in the caching device.

FIG.13

ID	Access Result	mux 1	mux 2	mux 3	mux 4	mux 5	mux 6	mux 7	mux 8	Fsel	Bsel
W	miss	R	R	B	S	S	R	R	F	1	6
W	hit 1	R	R	B	S	S	R	R	H	1	6
W	hit 2	S	R	B	S	S	R	R	H	1	6
W	hit 3	S	S	B	S	S	R	R	H	1	6
W	hit 4	R	R	B	F	S	R	R	H	1	6
W	hit 5	R	R	B	S	F	R	R	H	1	6
W	hit 6	S	S	S	S	S	R	R	H	1	6
W	hit 7	S	S	S	S	S	S	R	H	1	6
W	hit 8	S	S	S	S	S	S	S	H/S	1	6

Table 3

FIG.12A

Locked   Unlocked
Partition   Partition

110

	1	2	3	4	5	6	7	8
	C	D	A	B	F	E	H	G

140

150

H

↓S ↓S ↓S ↓L ↓L ↓S ↓S

Hit way number

C	D	A	B	F	E	H	G

Locking an element that is in
caching device but is unlocked.

FIG.14

Locked   Unlocked
Partition   Partition

110

	1	2	3	4	5	6	7	8
	C	D	A	E	B	F	H	G

140

150

R   R   H

↓S ↓ ↓ ↓ ↓S ↓S ↓S ↓S

Hit way number

C	A	E	D	B	F	H	G

Unlocking an element that is in caching device.

FIG.15